DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

THEORY OF OPERATIONS EXAMINATIONS, PREPARATION
AND VALIDATION OF

SPECIFICATION

1. SCOPE

1.1 Scope. - This specification sets forth the requirements for the preparation and validation of theory of operations examinations used in the Airway Facilities Personnel Certification Program for FAA personnel. These written examinations are used to determine whether or not the examinee possesses the knowledge required to perform tasks on a given equipment or system of equipments.

1.2 Definitions. - The following definitions are pertinent to this specification.

1.2.1 Alternative. One of several answers from which a correct choice must be made.

1.2.2 Choices. - A group of alternatives from which an individual is to select a correct answer.

1.2.3 Comprehensiveness. - A characteristic which describes how adequately an examination samples all of the major components of the subject area being tested.

1.2.4 Determiner. - A word or words in an examination item which telegraph the answer or otherwise assist the examinee in responding correctly regardless of his knowledge of the material.

1.2.5 Discrimination. - A characteristic of an item or an examination that describes how well it differentiates between the more knowledgeable and the less knowledgeable examinees. If an item is answered incorrectly more often by the more knowledgeable examinees, it is said to have negative discrimination.

1.2.6 Distractors. - Alternatives in a multiple choice item which are incorrect.

1.2.7 Examination Study Guide. - A summarization of test areas to aid the student in preparing for the examination and a listing of reference sources.

1.2.8 Face Validity. - A characteristic of an item which shows, by inspection, that the item contributes to measuring achievement of the training objective.

1.2.9 Item. - The smallest unit of examination construction, consisting of a stem and a group of alternatives.

1.2.10 Job task analysis. - A basic method used to obtain a detailed listing of the behavioral content of a job, including tasks, sub-tasks, and operations. Job analysis involves observation and dialogue with those who perform the job in order to describe in detail the variety of tasks to be performed, the conditions under which they must be performed, special tools and equipment required, the performance standard (level) necessary, and knowledge required.

1.2.11 Objective. - The aim or purpose of a course of action.

1.2.12 Objectivity. - That characteristic of an examination which describes how well it produces the same score for the examinee no matter who grades it; also called singleness of scoring.

1.2.13 Reliability. - A characteristic of an examination which describes how well it produces consistent responses. High parallel reliability exists when two forms of an examination, closely parallel in content and difficulty, yield very similar average scores for a given group of examinees.

1.2.14 Stem. - That part of a multiple choice item which asks the question or states the problem.

1.2.15 Task. - A specific action taken by an individual in performing his assigned job. A task is a unit of work that has identifiable starting and ending points and results in a measurable project.

1.2.16 Theory of operations examination. - A written examination covering the general principles and theory necessary to demonstrate that the examinee has the level of knowledge required for assuming the full responsibility for the proper configuration, operation, performance parameter checks, certification, starting procedures, system diagnosis, and other tasks related to the applicable system, subsystem, or equipment.

1.2.17 Training objective. - A description of the overt behavior by which ones capability can be observed and measured.

1.2.18 Usability. - That characteristic of an examination which describes how easy it is to administer and score.

1.2.19 Validity. - A term which describes the degree to which an examination, or an examination item, measures what it purports to measure. Validity encompasses the entire spectrum of examination characteristics, such as comprehensiveness, discrimination, objectivity, reliability, and usability.

2. APPLICABLE DOCUMENTS

2.1 FAA documents. - The following FAA specifications and standards in effect on the date of the invitation for bid or request for proposal, form a part of this specification and are applicable to the extent specified herein.

2.1.1 FAA specifications. -

FAA-D-2494/1	Technical Instruction Book Manuscripts: Electronic Equipment, Requirements for, Part I - Preparation of Manuscript
FAA-D-2494/2	Technical Instruction Book Manuscripts: Electronic, Electrical, and Mechanical Equipment, Requirements for, Part II - Preparation of Reproducible (Camera-Ready) Copy and Original Artwork

2.1.2 FAA standard. -

FAA-STD-010	Graphic Symbols for Digital Logic Diagrams

2.2 Government publications. - The following Government publications, of the issues in effect on the date of the invitation for bids or requests for proposal, form a part of this specification and are applicable to the extent specified herein.

2.2.1 Military Standards. -

MIL-STD-17	Mechanical Symbols (Other than Aeronautical, Aerospace, and Spacecraft Use)
MIL-STD-27	Designations for Electric Power Switch Gear Devices and Industrial Control Devices

2.2.2 Other Government publications. -

DOD 5220.22	U.S. Government Printing Office Style Manual Industrial Security Manual for Safeguarding Classified Information

2.3 American National Standards Institute (ANSI) publications. - The following ANSI publications in effect on the date of invitation for bid or request for proposal, form a part of this specification and are applicable to the extent specified herein:

ANSI X3.5	Flowchart Symbols for Information Processing
ANSI Y10.19	Letter Symbols for Units Used in Science and Technology
ANSI Y14.15	Electrical and Electronic Diagrams
ANSI Y32.2	Graphic Symbols for Electrical and Electronic Diagrams

ANSI Y32.9	Graphic Electrical Wiring Symbols for Architectural and Electrical Layout Drawings
ANSI Y32.16	Reference Designations for Electrical and Electronic Equipment
ANSI Z210.1	Metric Practice Guide

2.4 Institute of Electrical and Electronic Engineers (IEEE) standard. - The following IEEE standard in effect on the date of invitation for bid or request for proposal, forms a part of this specification and is applicable to the extent specified herein:

255	Semiconductor Devices, Letter Symbols for

2.5 Other publications. - The following publication, of the issue in effect on the date of invitation for bid or request for proposals, forms a part of this specification and is applicable to the extent specified herein:

Merriam-Webster's New International Dictionary

(Copies of this specification and other applicable FAA specifications and standards may be obtained from the Contracting Officer in the Federal Aviation Administration office issuing the invitation for bid or request for proposal. Request should fully identify material desired; i.e., specification, standard, and dates. Requests should cite the invitation for bid, request for proposal, contract involved, or other use to be made of the requested material.)

(Single copies of applicable unclassified Federal and military specifications and standards may be obtained from the Naval Publications and Forms Center (NPFC), Philadelphia, which is the Department of Defense Single Stock Point (DOD-SSP) and distribution center for unclassified specifications and standards. Documents may be obtained by writing: Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120; or by calling: Area Code 215, 697-3321, Monday through Friday, from 8:00 a.m. to 4:30 p.m. (Philadelphia time).

(Copies of the GPO Style Manual and Industrial Security Manual may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402).

(Information on obtaining copies of NASI documents may be obtained from the American National Standards Institute, Incorporated, 1430 Broadway, New York, New York 10018.)

(Information on obtaining copies of IEEE standards may be obtained from the Institute of Electrical and Electronic Engineers, 345 East 47th Street, New York, New York 10017.)

3. REQUIREMENTS

3.1 General. - This specification requires the development, preparation, and validation of written theory of operations examinations. The contractor shall prepare an examination plan for FAA approval. The approved examination plan forms the basis for developing the theory of operations examination. The theory of operations examination shall be submitted in manuscript form for approval and validation, and in camera-ready copy for final submission.

3.1.1 Examination plan. - An examination plan shall be developed for each theory of operations examination. The plan shall provide for development of a job task analysis, and training objectives (see 1.2 for definitions). The plan shall delineate those tasks, subtasks, and activities for which examination items will be developed and shall establish a testing objective for each. The plan will recommend, throughout a range, the number of test questions deemed appropriate. The latter may be specified in terms of test validity and comprehensiveness. The plan shall specify a maximum time limit for the examination. The contractor shall submit the examination plan to the Government for review and approval before proceeding with examination development.

3.2 Theory of operations examination development. - Each theory of operations examination shall be oriented toward measurement of the examinee's knowledge of the theory and practical techniques required to diagnose and correct deficiencies of specific equipments or systems of equipments as well as proper configuration, operation, performance parameter checks, certification, starting procedures, system diagnosis, and other tasks of a nonroutine nature. Unless otherwise specified in the contract or order, three versions of each examination, of approximately equal difficulty, shall be developed. Each examination shall be developed such that an individual achieving a 70 percent score possesses the requisite knowledge of the subject matter or equipment needed for certification.

3.2.1 Scope. - The theory of operations examinations shall be comprehensive, covering not only the equipment within a system, but also the auxiliary equipment considered to be a part of the system. Theory of operations examinations for software shall cover utility, support, and diagnostic programs as well as that part of operational programs, subprograms, routines, and subroutines which support the maintenance effort. Specific knowledge areas that may be covered in a theory of operations examination include, but are not limited to, the following:

(a) Principles of the theory of equipment operation including associated components.

(b) Sequential operation of controls and protective components during startup, normal operation, shutdown, and abnormal or fault conditions.

(c) Analysis of system abnormalities and determination of the corrective action required.

(d) Safety precautions to be observed.

(e) Documentation required prior to performing maintenance.

(f) Use of special tools and test equipment.

(g) Criteria for removal, disassembly, inspection, evaluation, and repair or replacement of system components.

(h) Testing requirements and procedures.

(i) Sequence and specifications for reassembly and checkout.

(j) Knowledge and use of technical documentaion.

3.2.2 Source material. - Source material for development of the theory of operations examination shall include, but is not limited to, systems handbooks, manufacturer's technical documents, available FAA Academy training plans, course and lesson outlines, course examinations, and training objectives. Where applicable, the Government will provide reasonable access to the system or equipment to be covered by the examination for job analysis, and access to personnel with knowledge of the equipment in order to conduct interviews.

3.3 Theory of operations examination design. - The written theory of operations examination shall be designed to measure the examinee's knowledge, understanding, and ability to apply the principles necessary in achieving the testing objectives (3.1.1). Each item shall have specific applicability to a training objective.

3.3.1 Item construction. - Theory of operations examination items shall be of the multiple choice type. Each item shall normally have four choices and shall be constructed according to the following general rules:

(a) The stem shall contain all matter pertaining to all choices so that the choices are as short and precise as possible.

(b) The stem content shall not give away the correct choice; avoid synonyms for the correct answer or pat phrases which can be determiners. Avoid the use of "always," "none," "never," or "all" since they may eliminate some of the distractors.

(c) Only items which call for knowledge essential to the system shall be used. Catch questions, leading questions, ambiguous questions, and questions on unimportant details shall not be used.

(d) Only words with precise meaning (working language) shall be used.

(e) The articles "a" and "an" shall not be used at the end of the stem; each alternative shall be grammatically parallel with the stem.

(f) Each item shall be independent of every other item. One item shall not give the answer to another item, nor shall the solution of an item depend on knowing the correct solution to another item.

(g) Graphics, such as sketches, diagrams, and flowcharts should be used when they present more job-like situations than do words. If large detailed graphics are used, the borders should be keyed (i.e., letters horizontally and numbers vertically) with a grid system, so that information in the item directs the examinee to the specific area, saving time lost in searching.

(h) Items shall be stated in positive terms.

(i) Numerical choices shall be listed in ascending or descending order of magnitude.

(j) All distractors shall be plausible.

(k) All alternatives should be approximately equal in length.

(l) Choices such as "all of the above" or "none of the above" shall not be used.

(m) Correct answers shall be placed in random position throughout the examination.

(n) Only one correct response shall be used for each item.

EXAMPLE 1:

A circuit contains three 15-ohm resistors connected in parallel. What is the total resistance of the circuit, in ohms?

A. 3

B. 5

C. 15

D. 45

EXAMPLE 2:

The sine slope up/down counter (schematic 20, GPA-131 video mapper):

A. shifts the five-bit data train into the add/subtract circuitry.

B. is reset at NR3, and responds to the input from the decode matrix.

C. senses the output logic from the 4096 counter to change the count in the slope counters.

D. is preset to all ones at NR3 and responds to the input from the decode matrix.

3.3.2 Style of writing. - The language used in constructing questions for the theory of operations examination shall be free of vague and ambiguous terms, and use the simplest words and phrases which will convey the intended meaning. Sentences shall be short and concise. Punctuation shall be used in a manner which aids in reading and prevents misreading; well-planned word order requires a minimum or punctuation. When extensive punctuation, or chain clauses, or both, seem necessary for clarity, the sentence shall be rewritten. The U.S. Government Printing Office Style Manual shall be used as a general guide for capitalization, punctuation, compounding of words, numerals in the text, and spelling of nontechnical words. For spelling of nontechnical words not found in the GPO Style Manual, Merriam-Webster's New International Dictionary shall be the guide. Words having more than one meaning that would fit the context used, such as "replace" for "reinstall," shall not be used. Statements concerning individual items or equipment shall use specific serial number(s), block designation(s), specific model designation(s), or similar identification. Such terms as "on later equipment," or "on earlier serial numbers" shall not be used. Abbreviations shall not be used.

3.3.3 References. - The text of items shall show:

(a) Temperature readings as calibrated on the equipment, with equivalent on the other scale (Fahrenheit or Celsius) following in parentheses.

(b) Speed, distance, and meter readings as calibrated on the equipment. If specified, conversion of U.S. measurements to the international system (S.I.) shall be made in accordance with ANSI Z210.1.

(c) Diagrams, signs, and symbols conforming to ANSI standards (see 2.3), FAA-STD-010, MIL-STD-17, MIL-STD-27, and IEEE STD 255, as applicable.

(d) Measurements in U.S. standard units, unless metric measurements are required. When metric measurements are required, they shall conform to ANSI Z210.1.

3.3.4 Grouping. - When more than one test item requires use of the same examination aid, such as a schematic, those items shall be grouped in sequence, and not scattered throughout the examination. When possible, items should be sequenced to follow the same progression of tasks that the examinee encounters on the job.

3.4 Format

3.4.1 Examination plan. - The examination plan shall be prepared in a format selected by the contractor.

3.4.2 Theory of operations examination

3.4.2.1 Manuscript. - Except as specified herein, manuscript or draft copies of all versions of the theory of operations examination shall conform to the applicable format requirements of FAA-D-2494/1.

3.4.2.1.1 Page layout and numbering. - Layout shall conserve space without lessening the clarity or useability of the material. Blank spaces shall be avoided, where possible, but layouts must not result in the first line of an item being at the bottom of a page, or the last line of an item being at the top of a new page. Pages shall be numbered consecutively with Arabic numerals.

3.4.2.1.2 Item numbering, spacing, and indentation. - Items shall be numbered sequentially with Arabic numerals, flush left. Text of items shall be double-spaced, indented one space from the item number. Carryover lines shall be alined with the first word of text. Items shall be separated by three spaces, adjusting as necessary to avoid dangling beginning and ending lines. Answer choices shall be double-spaced and designated sequentially with uppercase letters, indented three spaces from the stem text. Carryover lines shall be alined with the first word of the choice text.

3.4.2.1.3 Divisions. - The theory of operations examination shall be divided into sections, if appropriate, by the developer or as determined during the in-process review. Sections shall be numbered sequentially with Roman numerals, and begin on a separate page. The section number and title shall be centered on the page. Unless otherwise specified, consecutive numbering of pages and items shall be used.

3.4.2.1.4 Graphics. - Graphics furnished for review shall be reproduced copies of artwork in a form as near final as possible. To the extent practicable, schematics will be an integral part of the examination.

3.4.2.2 Camera-ready copy. - Camera-ready copy of all versions of the theory of operations examination shall be provided conforming to the applicable requirements of FAA-D-2494/2, except as specified herein.

3.4.2.2.1 Numbering, spacing, and indentation. - Pages and items shall be numbered consecutively with Arabic numerals, even if division into sections is made. Sections shall be numbered consecutively with Roman numerals. Text of item stems shall be single-spaced. The item choices shall be separated from the stem and each other by a single space. Items shall be separated by two spaces. Indentation shall be as specified in 3.4.2.1.2.

3.5 Key. - The contractor shall submit to the procuring activity a keyed copy of each version of the theory of operations examination, indicating the correct response to each question. The key shall be submitted with the manuscript and the camera-ready copy. The key shall be annotated to show the exact source of the information from which each question was developed.

3.6 Instructions for the examiner. - Each theory of operations examination shall be accompanied by a set of instructions for the examiner who administers the tests. Such instructions shall include, but are not limited to, general and special instructions for the examinee, materials required, aids furnished or allowed, and time allotted.

3.7 Validation. - Unless otherwise specified in the contract or order, validation will be independently performed by the Government to determine the comprehensiveness, discrimination, reliability, objectivity, and usability of the theory of operations examinations (see 4.3.2). (See 1.2 for definitions.) 90 days will be allowed for validation.

3.8 Security requirements. - The theory of operations examination will normally contain only unclassified matter. If classified matter is contained, the material shall be marked and handled in accordance with DOD 5220.22, Industrial Security Manual.

3.9 Study Guide. - For each examination or group of examinations, the contractor shall develop a study guide that is composed of one or more instruction sheets which collectively provide the examinee with a summarization of the objectives to be covered and a listing of references or self-help materials such as reading assignments, study questions, problems, practical application job steps, self-test items, diagram sheets, and other supplementary information to assist in studying for the objectives to be covered in the examination.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Except as otherwise specified herein, or in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure conformance to the requirements.

4.2 Quality program requirements. - The contractor shall establish a quality assurance program to ensure that all provisions of the contract or purchase order and this specification are satisfied. The quality assurance program shall be continuous and shall include, but not be limited to:

(a) Manuscript review for format, clarity, accuracy, readability, ease of understanding, and face validity of items.

(b) Technical review for balance, i.e., the number of items covering an essential knowledge area is directly proportional to the worth of that area to the overall understanding of the subject area of the theory of operations examination.

(c) Technical review to ensure that the guidelines (3.3.1) for item construction have been followed as closely as possible.

4.3 Government inspection. - Material furnished in accordance with this specification shall be subject to review and approval by the Government or its appointed representative prior to acceptance.

4.3.1 In-process review. - In-process review of the manuscript theory of operations examinations by the Government will be made as necessary to insure that the adequacy, accuracy, and content of the examinations meet requirements. This review shall not exceed 45 days.

4.3.2 Validation. - Validation of the manuscript theory of operations examinations will be performed by the Government (3.7). A validation of all versions of the proposed theory of operations examinations will be performed to determined conformance to applicable requirements of the governing documents, and the technical accuracy and adequacy of the content. The validation period shall not exceed 90 days.

4.3.3 Final review. - The Government will perform a final review of the completed reproducible (camera-ready) copy and original artwork to insure compliance with the requirements of this specification and that the technical requirements of specifications FAA-D-2494/1 and FAA-D-2494/2 have been met. The final review will insure that all FAA corrections have been incorporated.

5. PREPARATION FOR DELIVERY

5.1 Packaging of manuscript and art for review. - The manuscript copy and art for review shall be packaged in accordance with specification FAA-D-2494/1, except as specified herein.

5.2 Packaging of camera-ready copy and original artwork. - Reproducible (camera-ready) copy and original artwork shall be packaged in accordance with specification FAA-D-2494/2, except as specified herein.

6. NOTES

This section is not applicable to this specification.

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